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The Pfannenstiel or so called “bikini cut”: Still effective more than 100 years after first description

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Abstract The original Pfannenstiel incision is discussed including the technique, history, current indications, advantages, and disadvantages. Excellent cosmetic results, principles of less traumatic surgery, and a rare incisional hernia complication rate of about 0–2%, as well as long-time use characterise this access path to the pelvic organs first described by the German gynaecologist in 1900. Complications of nerve damage, however, should be recognised, especially when extending the incision too far laterally.

Keywords Pfannenstiel incision · Laparotomy · Incisional hernia · Minimally invasive surgery · Cesarean section

The life and work of Hermann Johannes Pfannenstiel (1862–1909)

Hermann Johannes Pfannenstiel (Fig. 1) was born in Berlin in 1862. He finished his medical studies and received his medical degree at the Gynecological Clinic of the Charité in 1885. Several years later he moved to Breslau, where he started work at the university hospital's gynaecological department. His senior professor was Heinrich Fritsch (1844–1915), one of the most well-known gynaecologists at that time, whose name as an inventor is well-known in medicine (Fritsch's retractor,



Fig. 1 Portrait of the German gynaecologist Hermann Johannes Pfannenstiel who lived from 1862–1909. In 1900, he described his famous incision technique, which is currently known as the “bikini cut”. Pfannenstiel died at age 47 from an infection to his hand following surgery of an inflamed ovarian cyst

Fritsch's manoeuvre, Fritsch's position). Lead by Fritsch, Pfannenstiel qualified as a gynaecologist and obstetrician. In 1896, he became an assistant professor. At the age of 40, Pfannenstiel was appointed head of the gynaecological and obstetrics department at the University of Giessen (1902–1907). In 1907, he was appointed a professorship at the University of Kiel, where he led the gynaecological clinic. In the same year, he was invited to the United States by the American gynaecological society and was made an honorary member. In 1909, at the age of 47, he died from an infection he contracted during an operation in Kiel.

Pfannenstiel was not only recognised as physician but also as a surgeon and a teacher. He left a comprehensive written work concerning the pathology of the ovaries, tumors of the uterus, and ovariectomy. His creativity and scientific spirit is mirrored by the fact that he is mentioned three times in Morton's Medical Bibliography [1].

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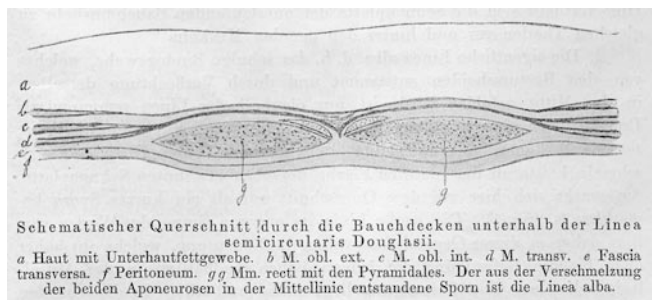


Fig. 2 Figure from Pfannenstiel's original article (1900) showing the anatomy of the lower abdominal wall. Schematic cross-section of the abdominal layers below the Linea semicircularis Douglasii. **a** skin and fat tissues **b** oblique external abdominal muscle **c** oblique internal abdominal muscle **d** transverse abdominal muscle **e** transversalis fascia **f** peritoneal layer **g** rectus muscles and pyramidalis muscles

One of his most famous publications was his description of a new incision technique in 1900. He had applied it in 51 laparotomies between 1898 and 1900 [2]. His detailed description of what was later called bikini incision is illustrated by didactic drawings of his own hand.

Technique

In his original paper (1900), Pfannenstiel describes and discusses his technique in great detail [2]. He describes the anatomy and depicts, that in the lower abdominal wall, the rectus muscles and accompanying pyramidalis muscles possess only a strong anterior fibrous sheath (including the aponeuroses formed by the fibres of the oblique external, the oblique internal, and transverse muscle) (Fig. 2). The fascia transversalis and peritoneum behind the rectus muscles have minimal impact on the stability of the lower abdominal wall (Fig. 2) [2].

Pfannenstiel maintained that the stability of the lower abdominal wall depends predominantly on the fibrous sheath in front of the rectus abdominis muscles. He emphasized that using his special incision technique would help to preserve this important anterior fibrous sheath (Fig. 3).

The first step in Pfannenstiel's technique is a curved transverse cut, just below the hair border (Fig. 4). This incision includes the subcutaneous layers and is about 8–12 cm in length (approximately from one superficial epigastric artery to the other). Only in rare cases of obese patients is it recommended to extend this incision more laterally. In the same way, a deeper 8–10-cm long transversal cut is made. This incision includes the thin superficial fascia and the fibrous rectus sheath mentioned above, which contains the fascia of external oblique, internal oblique, and transverse muscle. If necessary, this cut can be extended further laterally through the muscle edges. The aponeurosis (including attached fibres of the linea alba) is then separated from

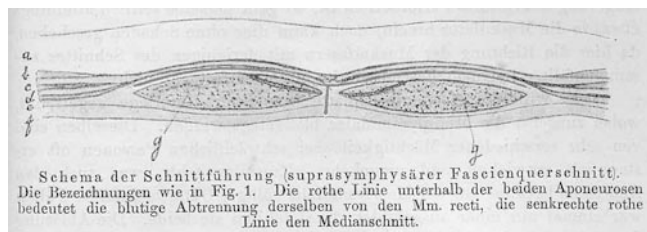


Fig. 3 Figure from Pfannenstiel's original article (1900) showing the technique of the incision schematically. Legend as in Fig. 2. The line below both aponeuroses indicates their separation from the rectus muscles during the procedure. The vertical line indicates the midline incision

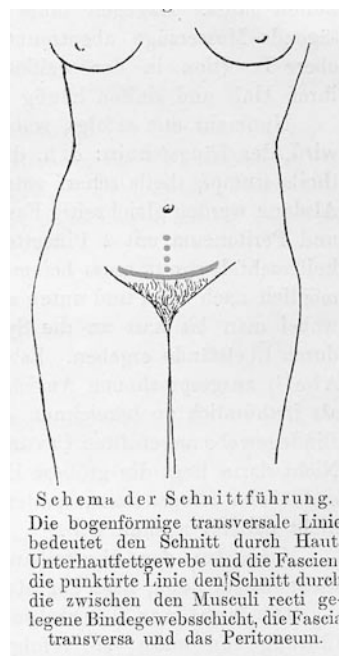


Fig. 4 Drawing from Pfannenstiel's original article (1900) showing the incisions schematically. The curved horizontal line indicates the incision of skin, subcutaneous tissues, and the fascia (anterior rectus sheath). The interrupted vertical line indicates the incision between rectus muscles, transversalis fascia, and peritoneal layer. Note the right-angled position of the incisions and the minimal possible crossing area

the underlying pyramidalis and rectus muscles approximately 6 cm cranially (from symphysis to umbilicus).

The second important part of the Pfannenstiel access path into the lower abdomen is the vertical incision.

It includes the separation of the rectus abdominis muscles in the midline, dividing the fascia transversalis, preperitoneal fat tissue, and peritoneum (Fig. 3).

Pfannenstiel recommended closing his incision in four (minimum three) layers. According to the author, the peritoneum, the rectus muscles, the transversely incised fascia, and skin, including the subcutaneous layers, should be sutured.

Past indications

Pfannenstiel invented his technique to improve the access path in gynaecologic and obstetric procedures and to create an alternative to the colpotomy, which included the risk of scar-tissue formation within the vagina with complications during a later delivery [2]. His intentions were also to improve the cosmetic result, as well as to avoid the disadvantages of conventional vertical laparatomies including formation of extensive scar tissue and the risk of developing of incisional hernias.

In his original work, Pfannenstiel describes inflammatory processes within the pelvis and genital organs, smaller ovarian tumors, myoma of the uterus, and tubal pregnancy as major indications for his technique. Hence, the site of the incision is necessarily restricted by the lateral extent of the skin incision, Pfannenstiel emphasises that his incision should be omitted in cases of larger tumors within the pelvis and uterus or cervix neoplasia.

Current indications

Nowadays, the Pfannenstiel incision is commonly used in cesarean sections and other gynaecologic and obstetric operations [3]. And also urologic and general surgery interventions, like prostatectomies [4], appendectomies [5, 6, 7], inguinal hernia repairs [8], and sigmoid resections for colocolponeopoesis [9], have been described using this technique. Recently a modified Pfannenstiel incision for intact specimen extraction after retroperitoneoscopic renal surgery has been described [10]. The Pfannenstiel incision has been used also in laparoscopic hepatectomy for benign liver tumors [11], laparoscopically assisted subtotal colectomy [12], and laparoscopically assisted colectomy with ileoanal pouch construction [13]. In such laparoscopic procedures, the Pfannenstiel incision facilitates the removal of resected organ parts and also enables access during interventions that cannot be accomplished with the aid of laparoscopic techniques alone.

Advantages

Compared to other access paths, for example, the low midline incision with hernia percentages reported of up to 46% [3, 14], the Pfannenstiel incision has shown lower incisional hernia rates of only 0–2% (Table 1) [2, 3, 4, 5, 15]. This can be related to the technique.

The skin incision is along the Langer's lines, resulting in reduced traction at the skin edges.

The transverse division of the anterior fibrous sheath of the rectus abdominis muscles is parallel to its fibres, along the lines of tension [2, 16], which improves the wound stability and healing conditions. The forces required to approximate a vertical abdominal incision are approximately 30 times greater than the forces required to approximate a transverse abdominal incision [16, 17].

Table 1 Incisional hernia incidence following original Pfannenstiel incision in literature since its first description by Pfannenstiel in 1900

Author and year	<i>n</i>	Incidence of incisional hernia	Follow-up period
Pfannenstiel (1900) [2]	51	0 of 51 = 0%	0.5–1.5 years
Biswas (1973) [5]	143	0 of 143 = 0%	2–4 years
Griffiths (1976) [4]	411	2 of 411 = 0.5%	9–14 years
Luijendijk (1997) [3]	243	5 of 243 = 2.1%	1.6–7.8 years

The linea alba, which has the poorest blood supply of any area in the abdominal wall, is predominantly preserved using the Pfannenstiel incision. Compared to the upper abdomen, the linea alba is much thinner in the lower abdomen (below the semicircular line) consisting of only few fibres, which continue their anterior and caudal course close to the anterior sheath of the rectus abdominis muscles.

The incisions made are perpendicular to each other with the chance of a possible overlapping area kept to a minimum. Beneath the superficial transverse incision is vital tissue, while the fibrous aponeurosis in front of the deeper vertical incision remains intact as well. In Pfannenstiel's incision, the skin, subcutaneous tissue, and fascial defect are remote from the muscle defect. The muscle defect is covered by predominantly healthy nonincised tissue, whereas in the low midline incision, all layers are cut in one plane, making, for instance, contamination and delayed wound healing more likely.

Using Pfannenstiel's technique, the prerequisites for an optimal healing process are preserved, which is mirrored by fewer wound infections compared to other techniques [5, 6, 18]. There seems to be little haematoma formation [5, 18] and less postoperative pain [6, 18]. An outstanding advantage is the better aesthetic appearance [5, 6, 7, 15, 17] of this access path also known as "bikini incision" or "bikini cut".

Gynaecologic surgeons often use a suprapubic incision for obstetric and pelvic surgery, and since the initial description by Pfannenstiel [2], numerous other transverse incisions have been reported. However, they do not necessarily show better results than the original Pfannenstiel description [19, 20]. For example, a transverse cut through the rectus abdominis muscles following the transverse skin incision will often result in disastrous incisional hernias, in which the rectus muscles lose their contact with the pubis. One recent case report describes massive bowel and bladder herniation in a woman following a lower transverse abdominal incision, which is designated as a Pfannenstiel incision [21], but it is doubtful, if the appropriate technique was chosen and all layers were cut and closed as recommended by the author.

Disadvantages

Some authors note the restricted access to the operating area [5, 6, 7, 16, 17]. Especially in cases of patients with

ovarian tumors or other malignant diseases, the use of the Pfannenstiel incision might be disadvantageous because of the insufficient possibilities for exploration of the upper abdomen for tumor expansion [22]. Little is known about this technique in patients with prior lower abdominal midline incisions, where scar tissue is already present.

Nerve damage and entrapment is not uncommon (and should be recognised) after a Pfannenstiel incision [23, 24, 25]. Nerve entrapment can result from an incision followed by neuroma formation, incorporation of the nerve by a suture in the closure of the fascia, or the tethering or constriction of the nerve in the surrounding scar tissue.

Because the femoral branch of the genitofemoral nerve passes under the inguinal ligament and its genital branch runs through the inguinal canal, these nerves are rarely entrapped. Injuries of the anterior branch of the T12 subcostal, iliohypogastric, and ilioinguinal nerves while performing the Pfannenstiel incision are more likely to occur [25]. This correlates to the nerves' superficial course.

The length of the incision could be identified as a risk factor for nerve entrapment, and nerve complication was found to occur far more often when the incision was extended laterally, beyond the edge of the rectus sheath [3]. When possible, the iliohypogastric and ilioinguinal nerves, as well as the anterior branch of the T12 subcostal nerve, should, therefore, be identified and preserved, especially when extending the incision more laterally.

A too-lateral incision of the anterior rectus sheath might also result in cutting through the external and internal aponeuroses, increasing the risk for incisional hernias if not properly closed. Some authors describe a significantly increased incidence of indirect inguinal hernia following Pfannenstiel incisions in men compared with vertical abdominal incisions for prostatectomy [4]. The mechanism for this was thought to be due to injury and changes in the structure of the inguinal canal when extending the incision too far laterally. Following Pfannenstiel's original description in all its detail would avoid this [4].

Conclusions and future

The Pfannenstiel incision is still a popular access to the pelvic organs, especially in gynaecological and urological procedures. Its disadvantages are more than counterbalanced by the advantages. In the literature, the Pfannenstiel incision shows a lower complication rate compared with the low midline incision and minimises scar formation. Complications of nerve damage in both genders and indirect inguinal herniation in males, however, should be recognised, especially when extending the incision further laterally. Thus, for obese patients and for extensive deep pelvic procedures, this access path should not be chosen.

Excellent cosmetic results, principles of atraumatic surgery without tension, and a rare incisional hernia complication rate of about 0–2%, as well as long-time use characterise the Pfannenstiel incision, which is still effective, more than 100 years after its first description in 1900. Furthermore, it has become increasingly important as a complementary technique in laproscopic surgery.

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